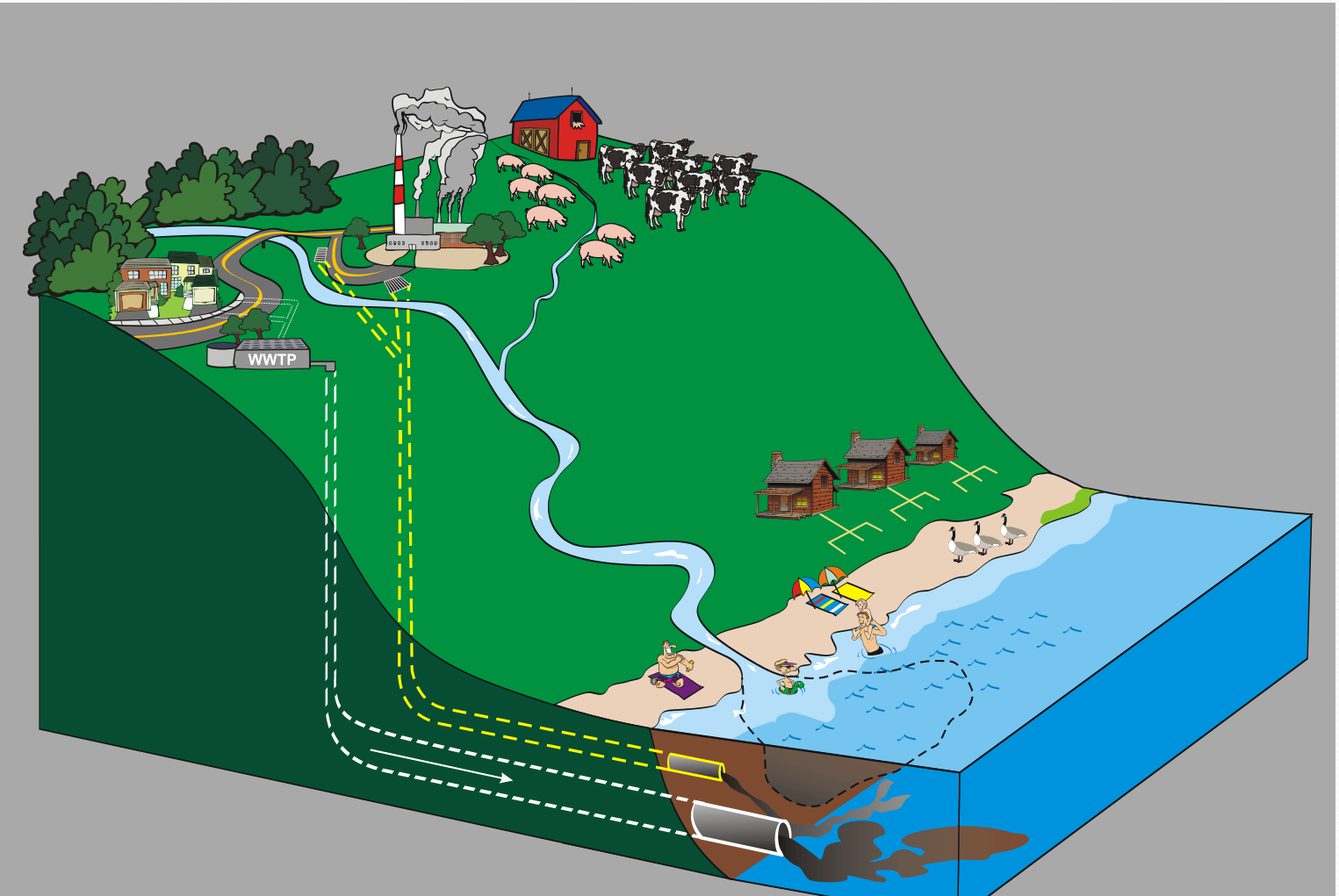
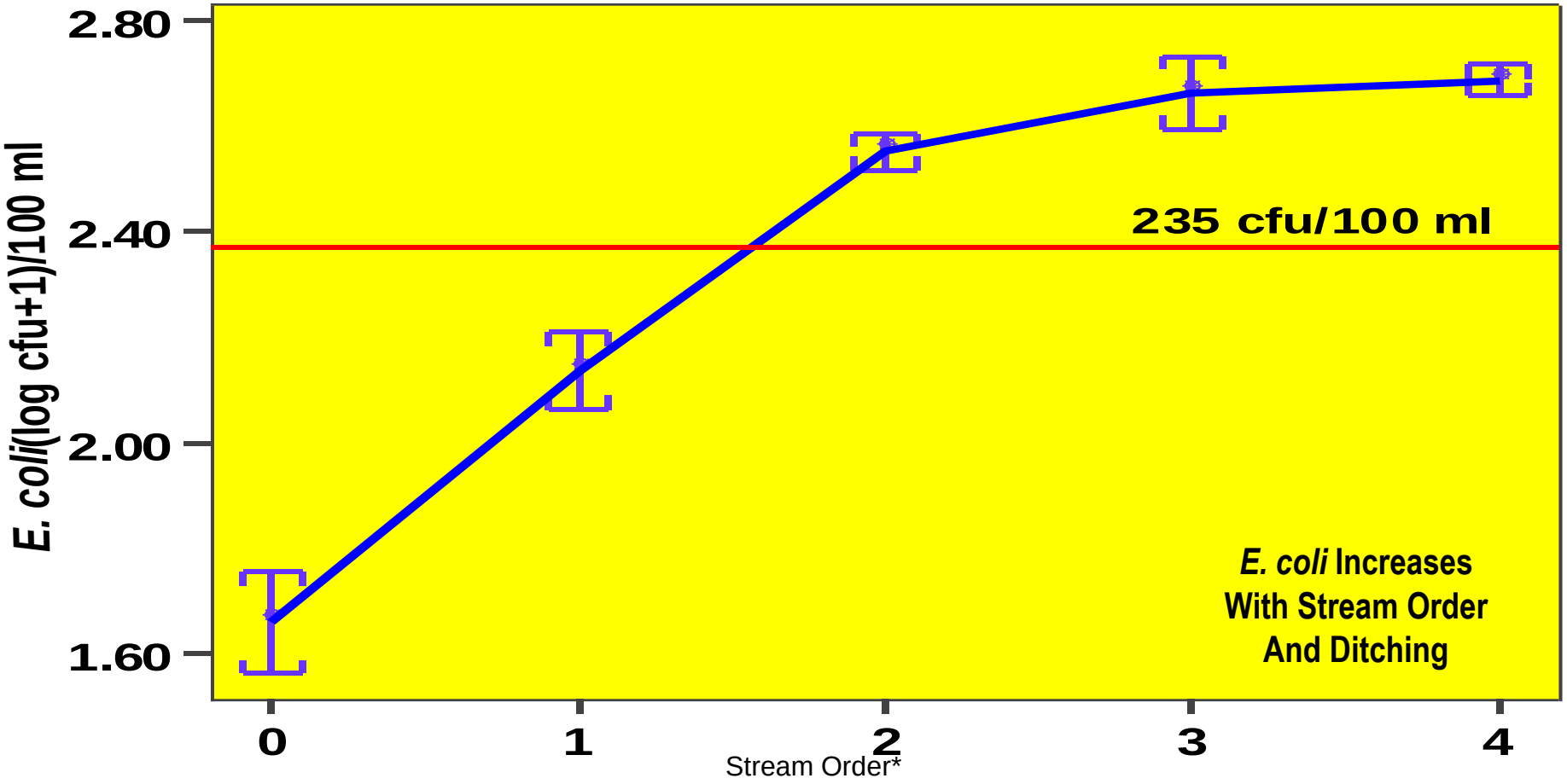
Water Quality Summary

Lot’s of proximate causes



Ditching, impervious surfaces, shoreline and wetlands loss Increases pollution



Dunes Creek, Indiana Dunes National Park. Whitman et al., 2002

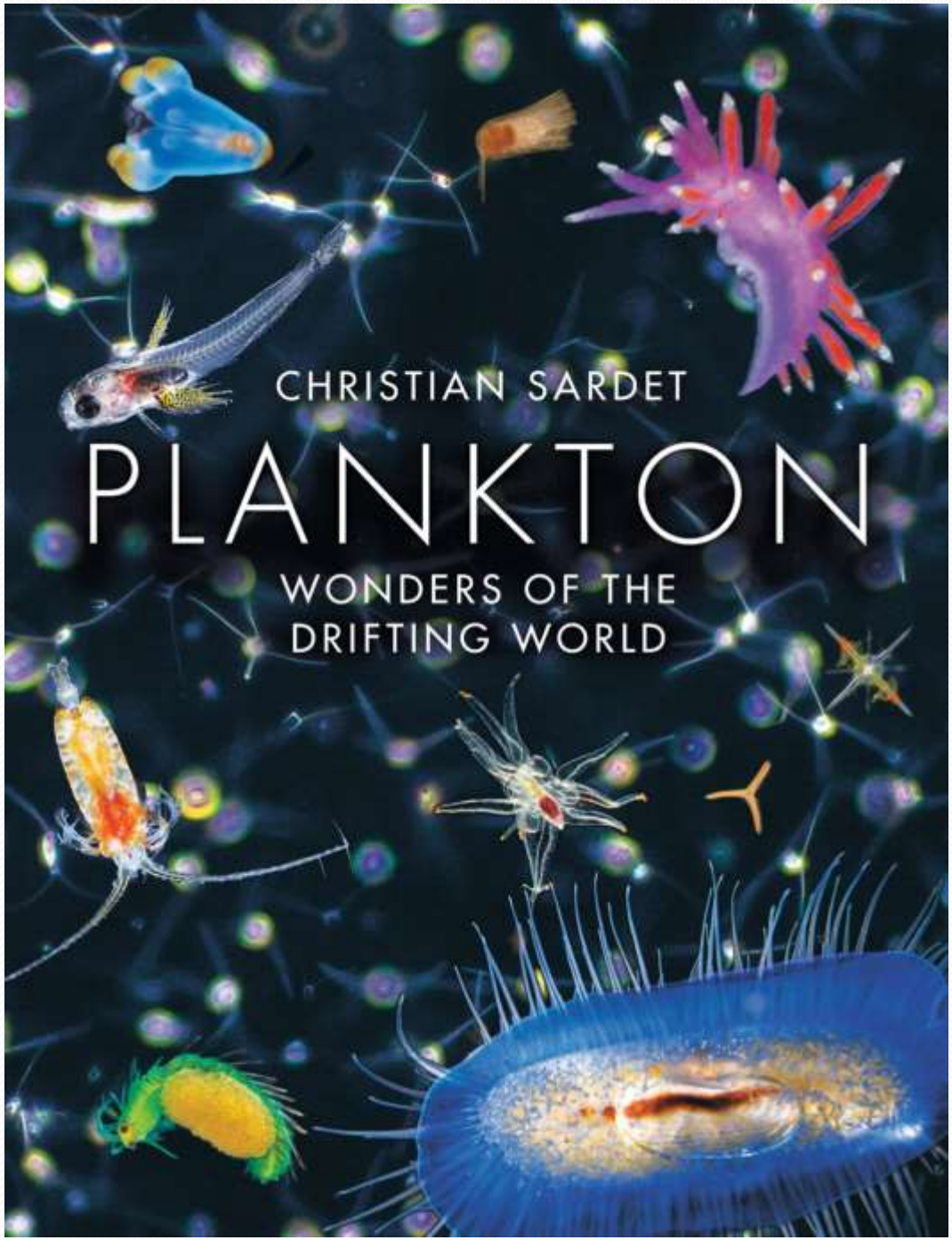
Drainages of Upper Charlotte Harbor

The Ecosystem Unseen
Navigating the World of Plankton

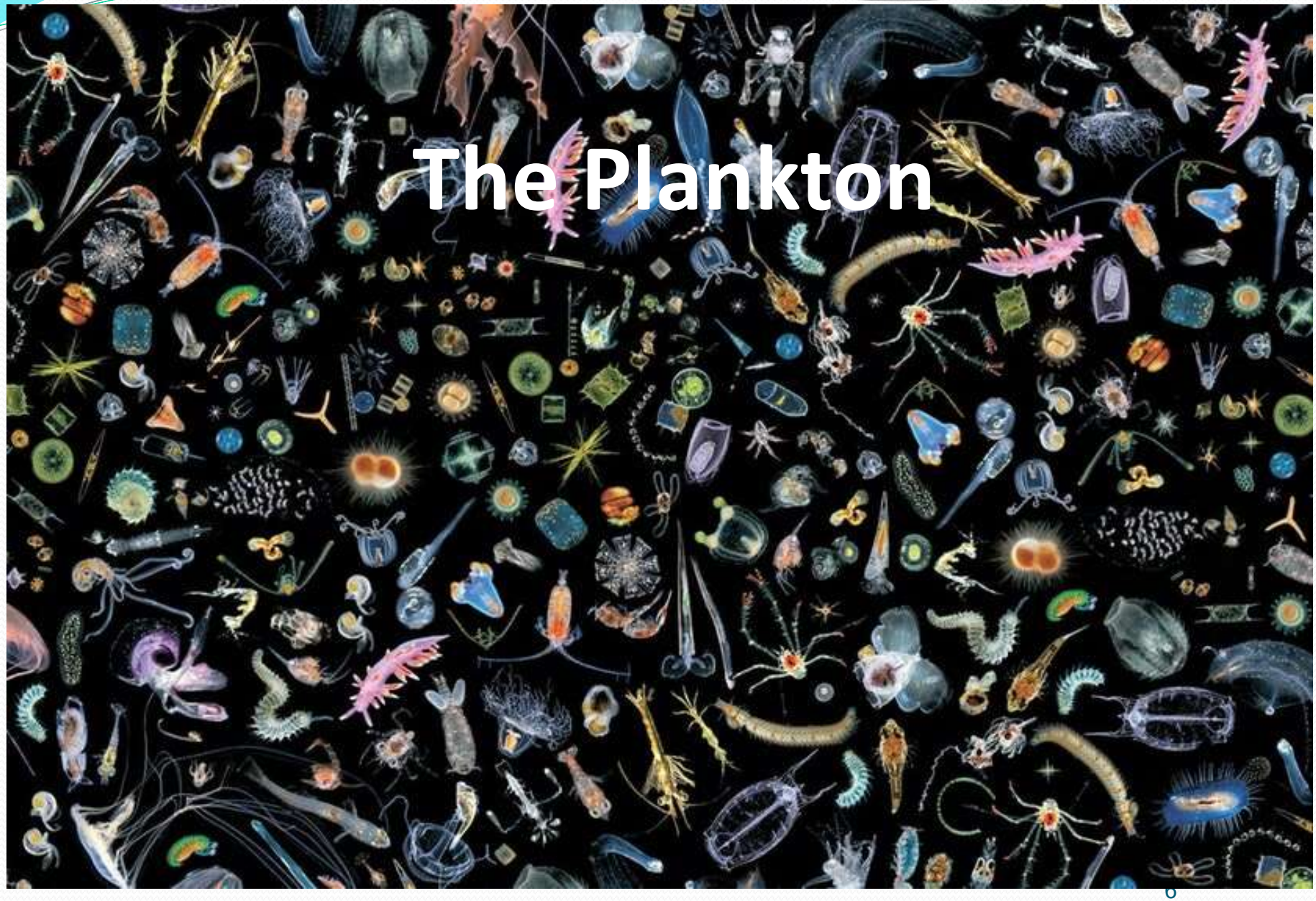
Charlotte Harbor Ambassador Training 2024

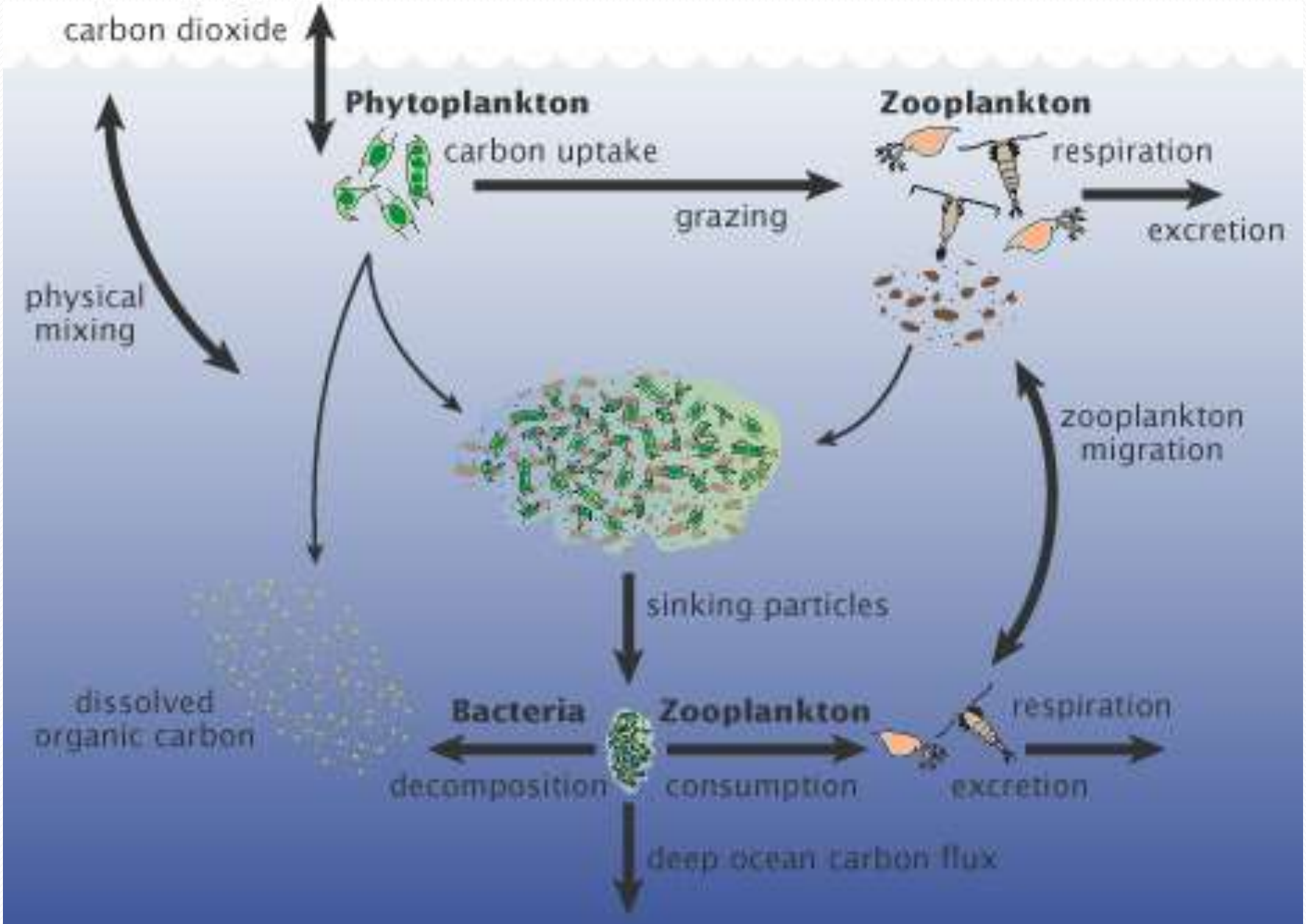
Heal Our Harbor

Richard Whitman, PhD


CHRISTIAN SARDET
PLANKTON
WONDERS OF THE
DRIFTING WORLD

The Plankton




carbon dioxide
Phytoplankton
carbon uptake
grazing
Zooplankton
respiration
excretion
physical mixing
zooplankton migration
sinking particles
dissolved organic carbon
Bacteria
Zooplankton
respiration
decomposition
consumption
excretion
deep ocean carbon flux

What exactly are **plankton?**

1. Plankton are weakly swimming or drifting organisms

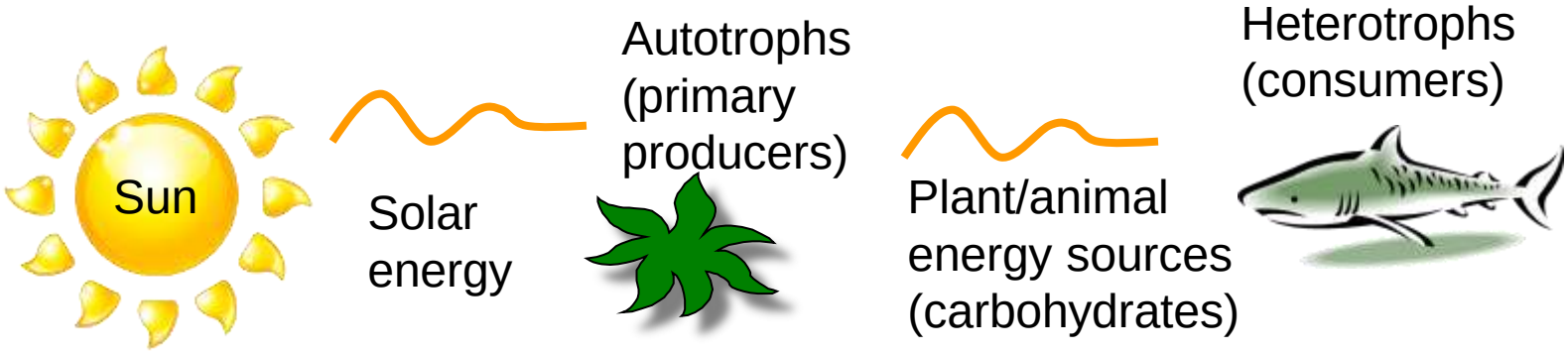
2. “Plankton” is not a single species but a large group of organisms that fall into two primary categories:
    - Phytoplankton (algae, protists, cyanobacteria)
    - Zooplankton (animals and protists)
    - Propagules
3. New word alert: nano-, micro-, meio-, macro- fauna, flora

Photosynthesis primer

- Recall from biology that **autotrophs** (aka **primary producers**) like plants or algae create carbohydrates (usable energy) from light through **photosynthesis:**

  $CO_2 + H_2O = C_6H_{12}O_6$ (carbohydrate) + O_2(oxygen)

- This energy supplies entire food webs as organisms are eaten up the food chain



Why are plankton important?

- Important part of global carbon cycle
- Food source (basis of the food web)
- Producer of oxygen (photosynthesis)
- Carbon sink (climate change)

Plankton are an energy source for marine ecosystems

- Many plankton are primary producers
- Over 90% of marine primary production (energy produced) is from phytoplankton! The rest is from marine plants and other sources.

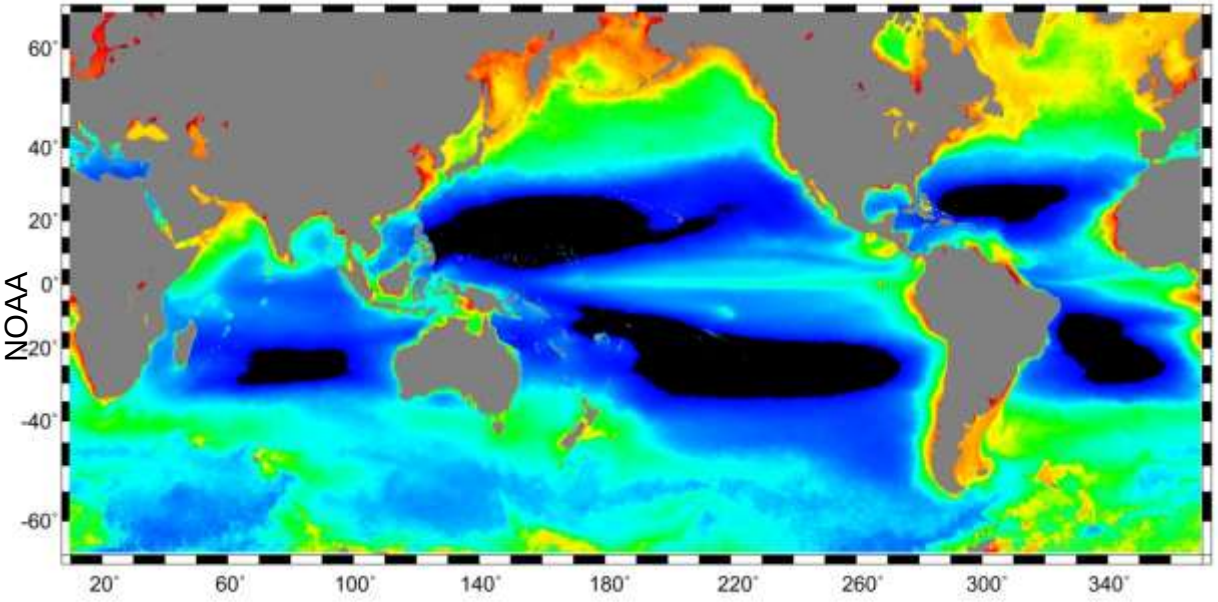


Photo: NOAA

This map shows productivity in the Oceans

Red and yellow are most productive, followed by green and blue. Black is least productive.

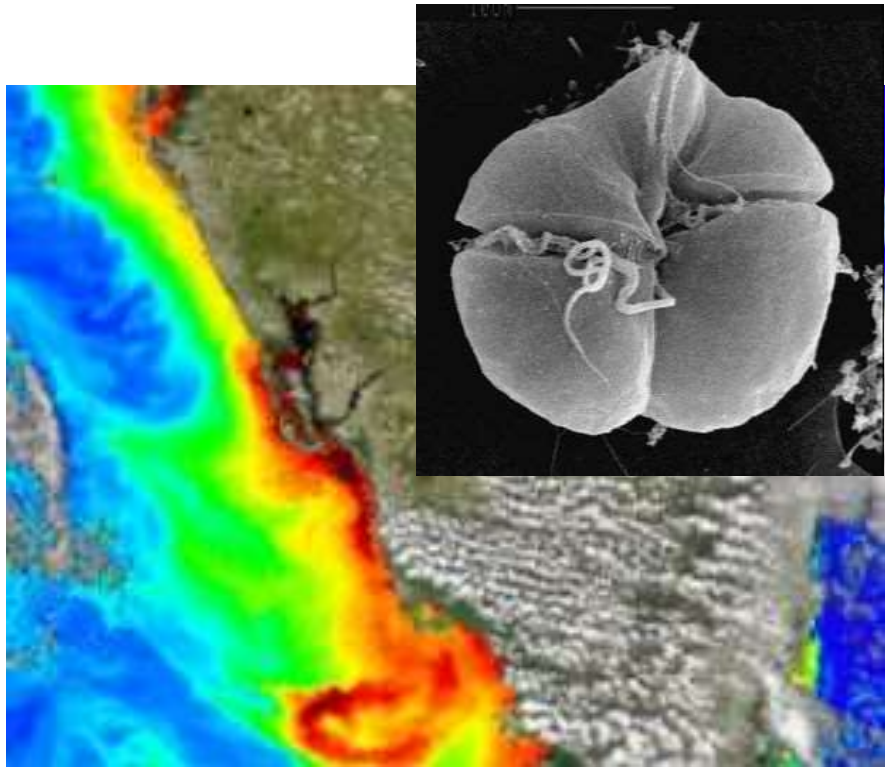
How are plankton studied?

- Special nets
- Underwater cameras
- Microscopes
- Satellites

Satellites can also help scientists study plankton

- Satellites equipped with color scanners measure the concentration of chlorophyll in the ocean
- Red and orange indicate higher concentration of chlorophyll, while blue and green represent lower concentrations
- Chlorophyll is an indicator of plankton and can be used to study plankton populations

K. brevis

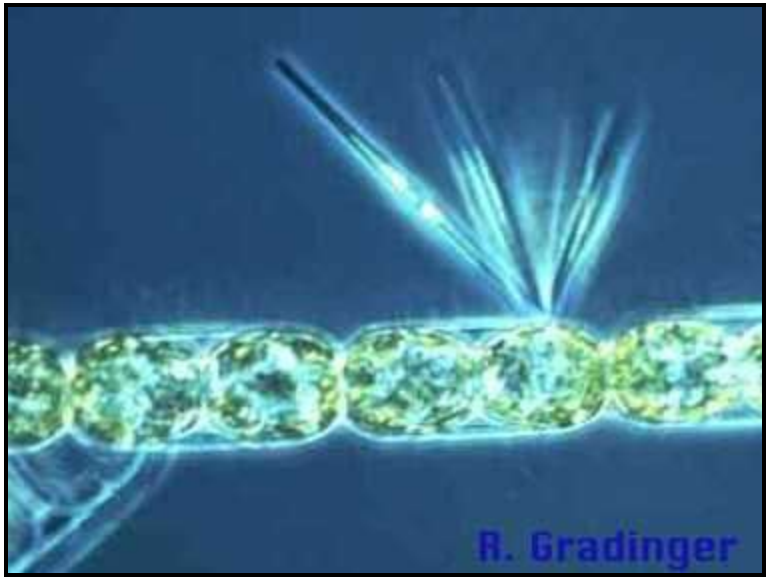


Satellite image of the Gulf of Mexico, NASA

Do organisms spend their entire lives as plankton?

- **Holoplankton** spend their entire life cycle as plankton
- Examples include dinoflagellates, diatoms and krill

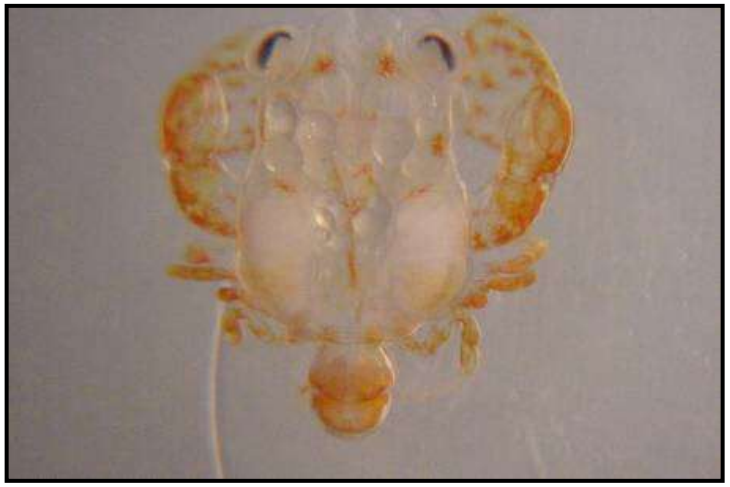
Photo: Rolf Gradinger, NOAA/OER



Diatom (Unicellular phytoplankton)

Do organisms spend their entire lives as plankton?

- **Meroplankton** spend only a part of their life cycle drifting
- As they mature they become **nekton** (free swimmers) or **benthic** (crawlers)
- Examples include blue crab and tarpon larvae



How are phytoplankton different from zooplankton?

Phytoplankton

- Producers
- Single cells or chains of cells including the smallest plankton – **picoplankton** (0.2 -2 microns)
- Remain near the surface

Zooplankton

- Consumers (including herbivores and carnivores)
- Include microscopic and macroscopic organisms
- May vertically migrate (to a depth of 200m) during the day for protection but resurface at night to feed

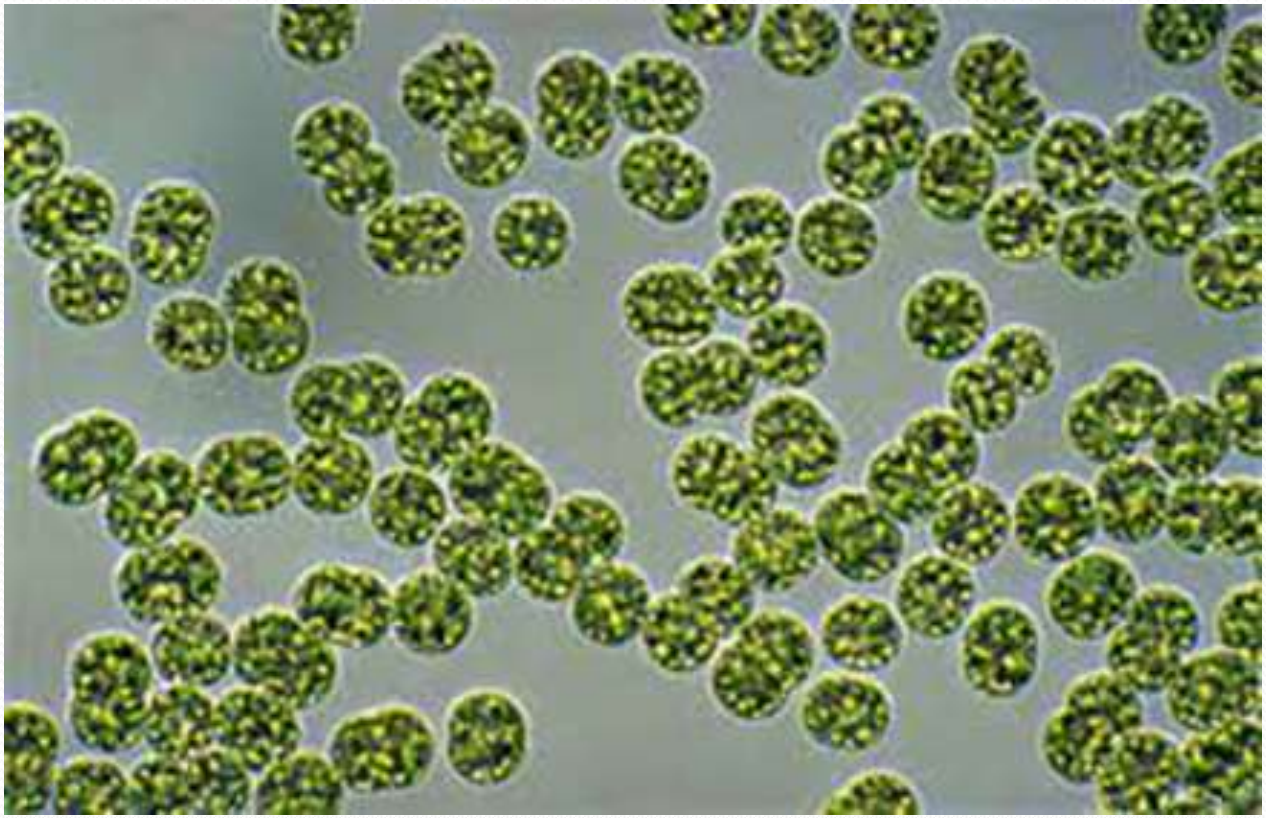

A
100 µm

Diatoms

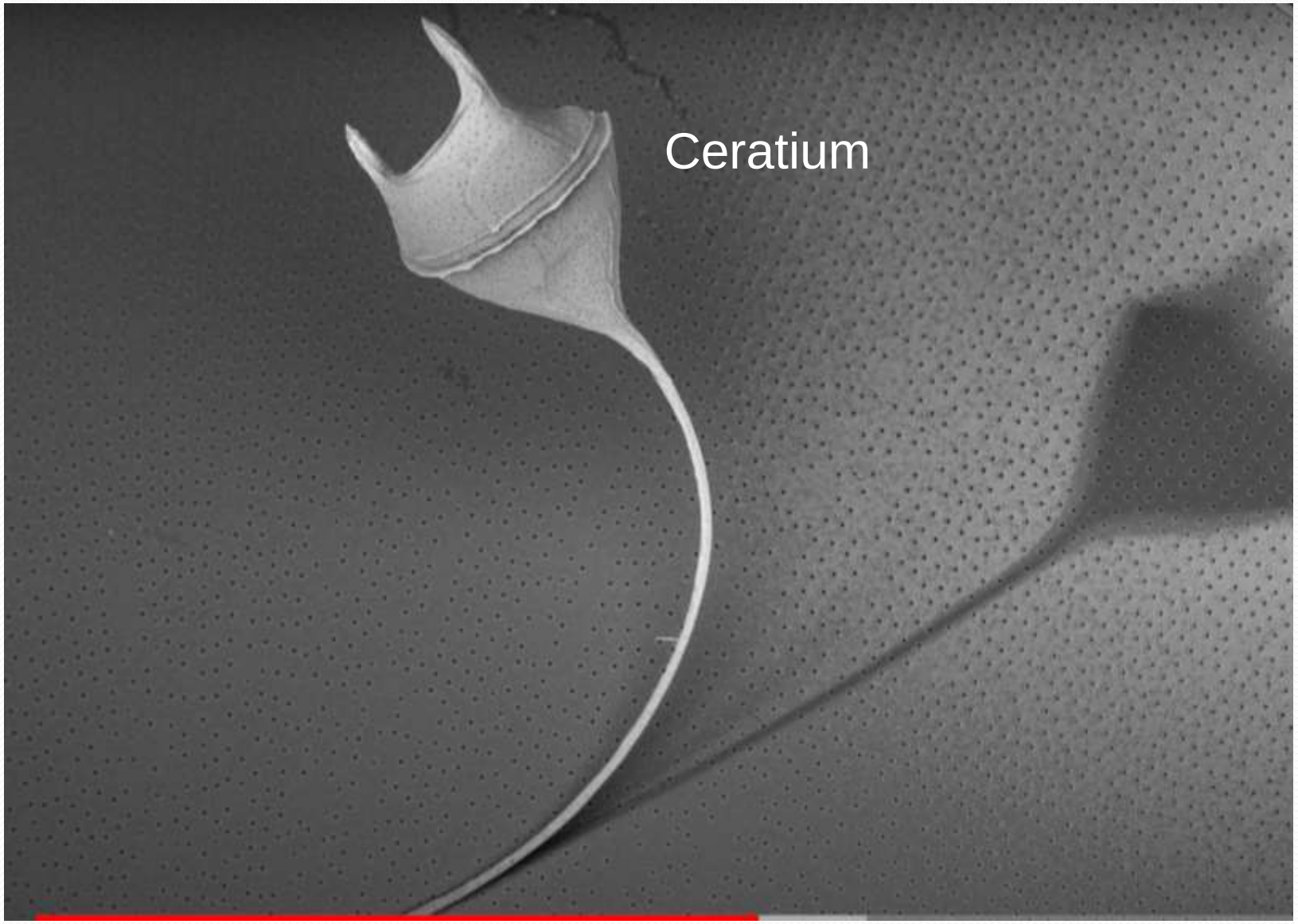
Centrate

Pennate

Protists (Dinoflagellates)



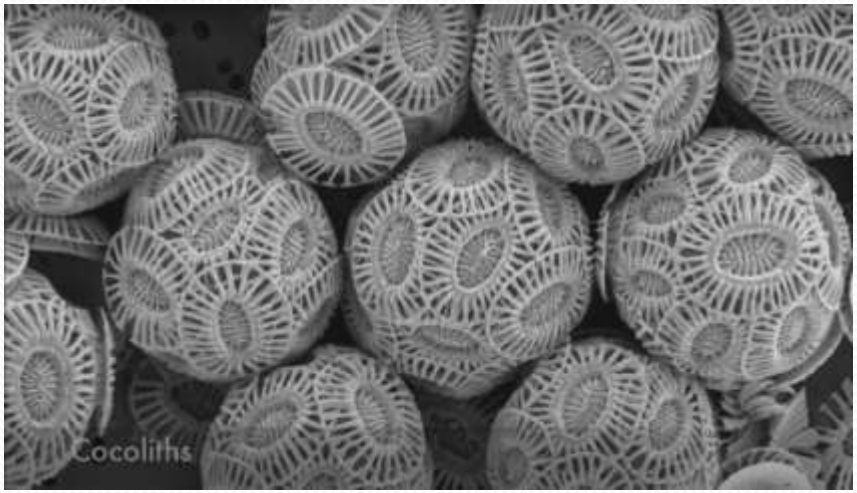
Karina brevis, Red Tide


Ceratium

Protists

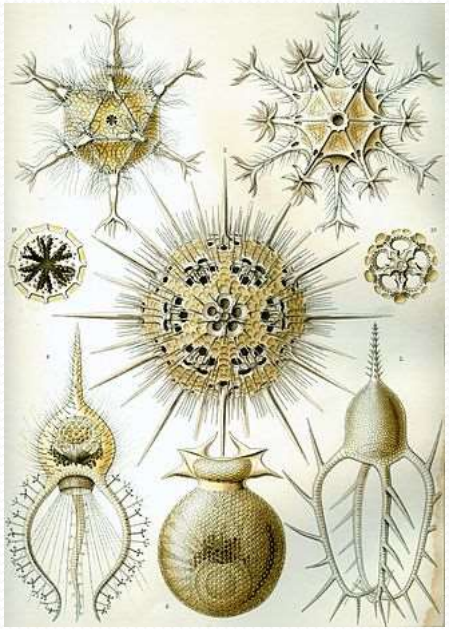
Coccoliths (chalk)

Phytoplankton, calcium



Radiolarian

Zooplankton, silica



from Christian Sardet: Plankton, Wonders of a Drifting World. Univ. Chicago Press

Texas A&M Univ

‘Immortal Jellyfish’ (plankton), converts to polyp stage (benthic) when threatened.

Comb Jellies

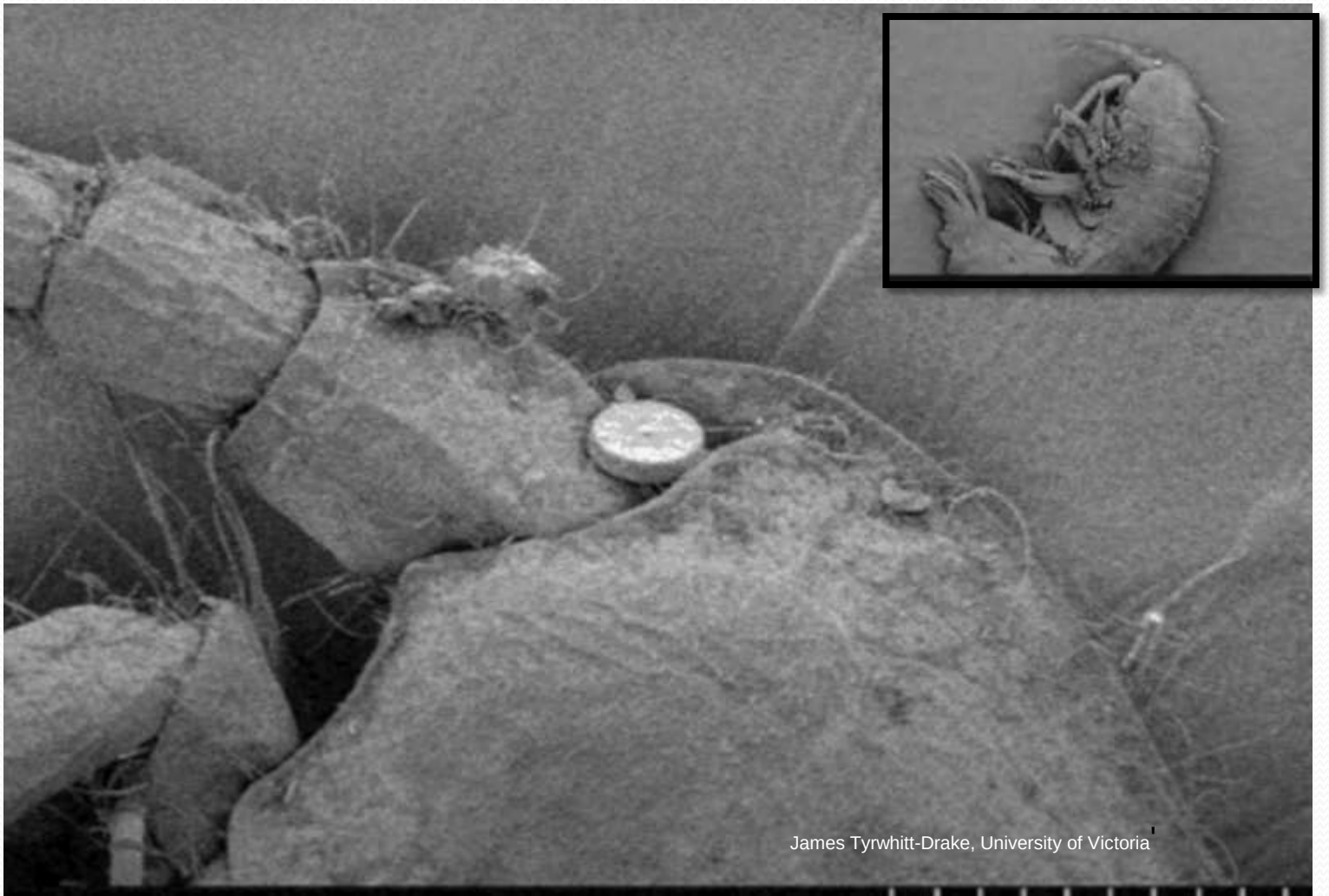
NOAA

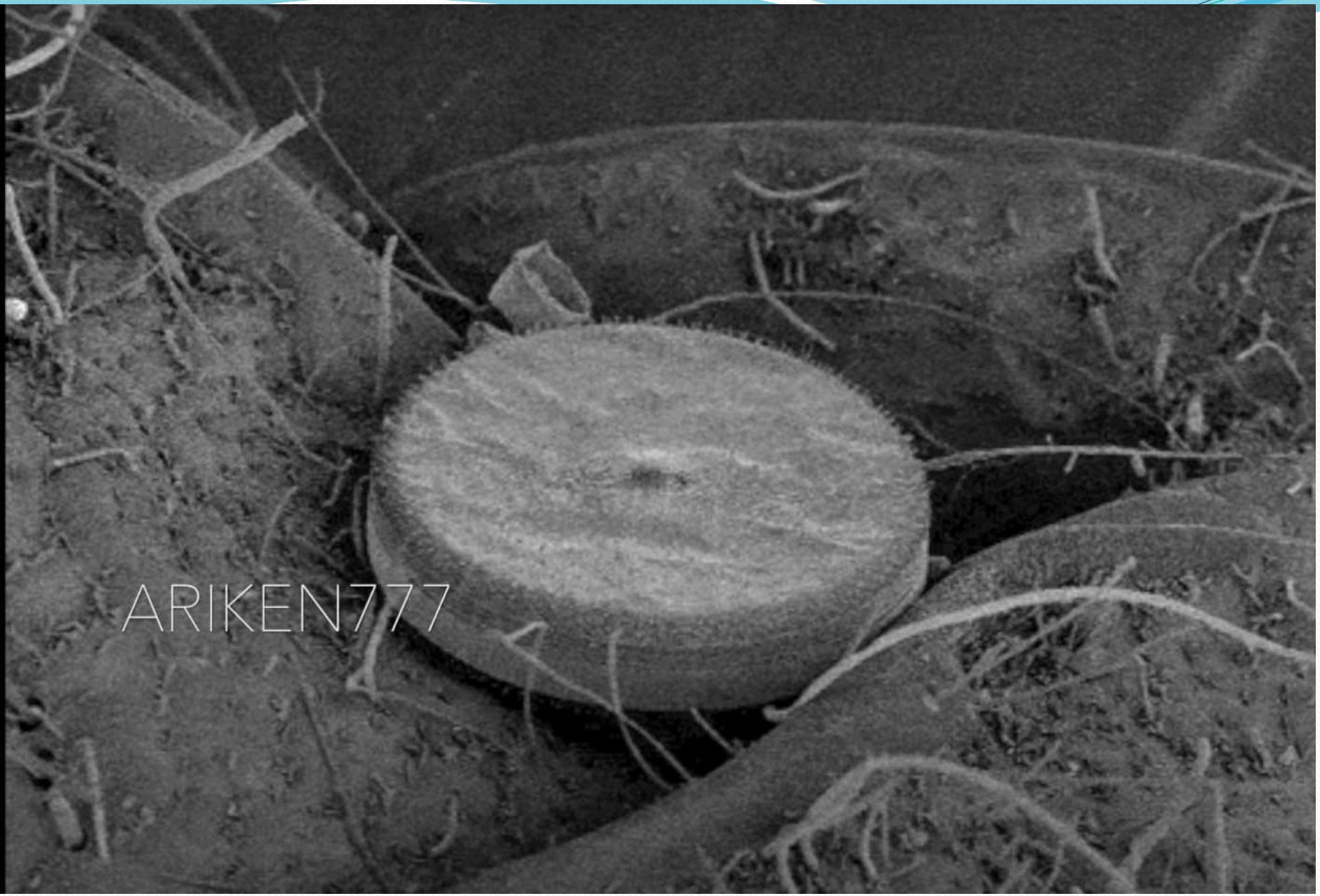
Larval Sea Snail Stages

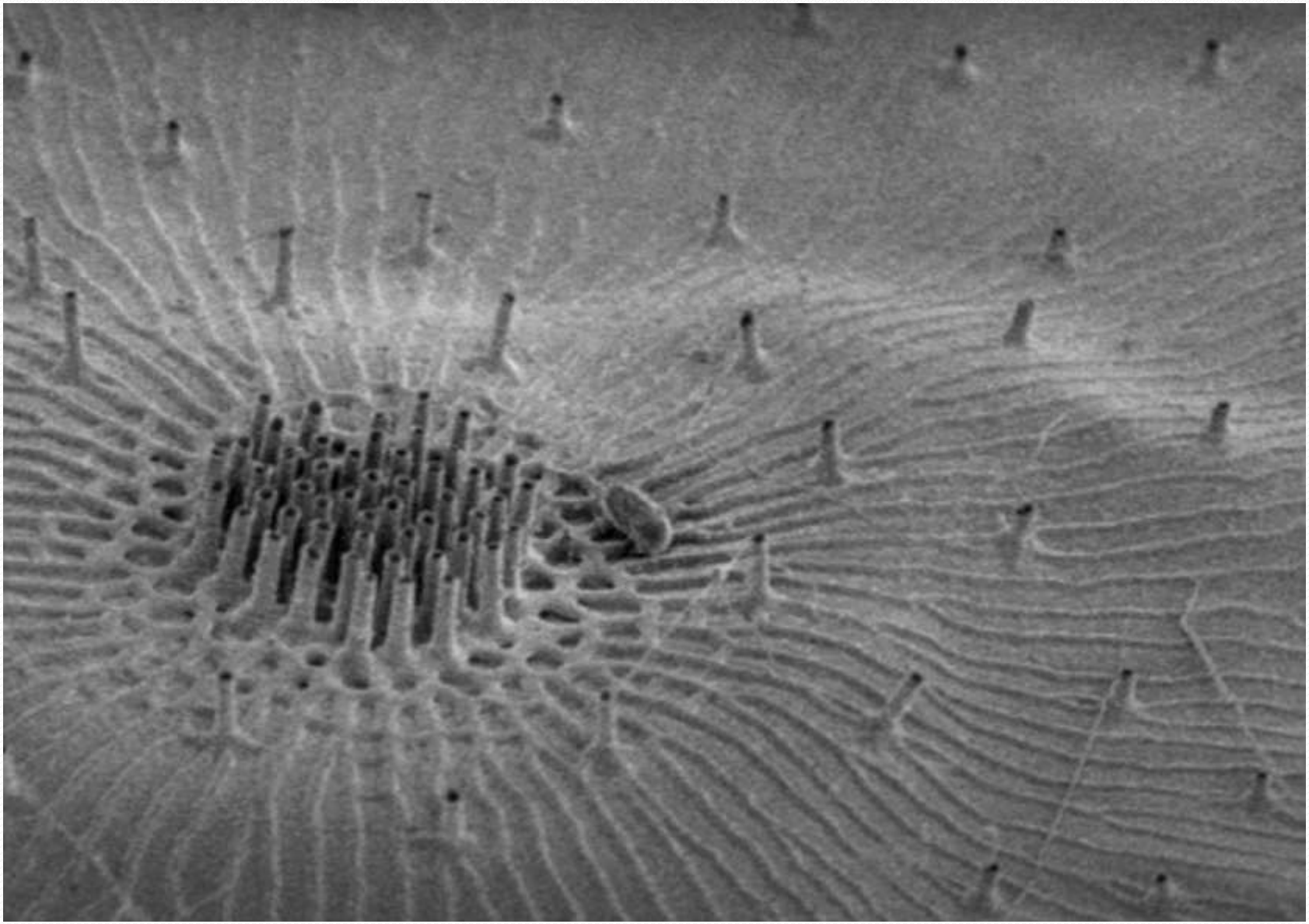
videohive.net-Envato Forums

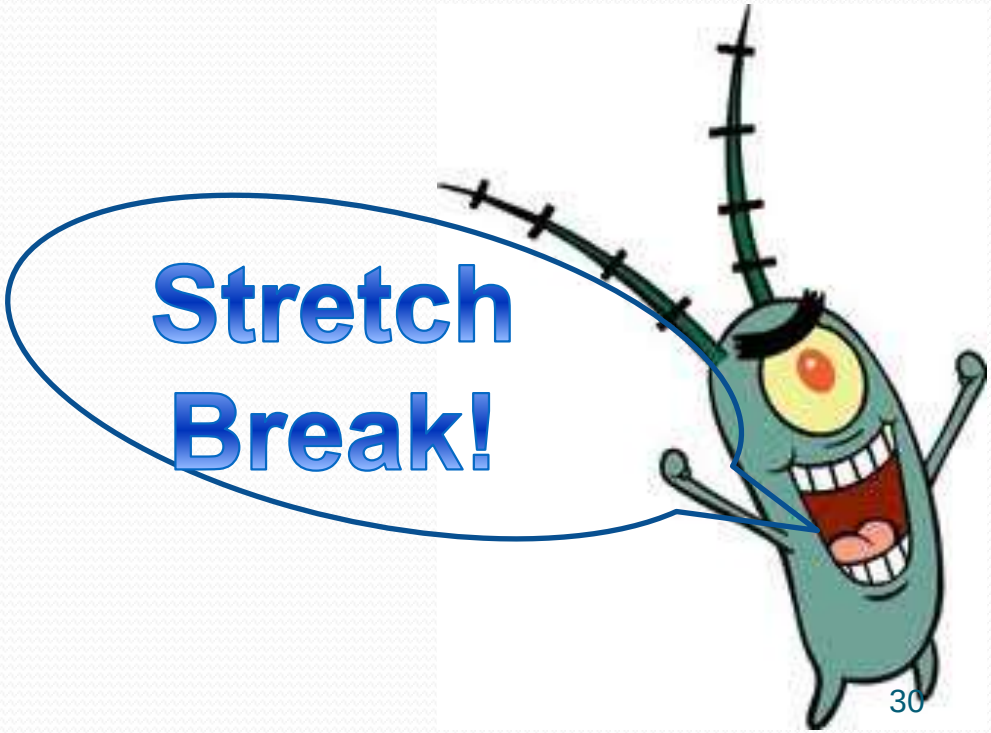
- from Christian Sardet: Plankton, Wonders of a Drifting World. Univ. Chicago Press

Amphipod with centric diatom



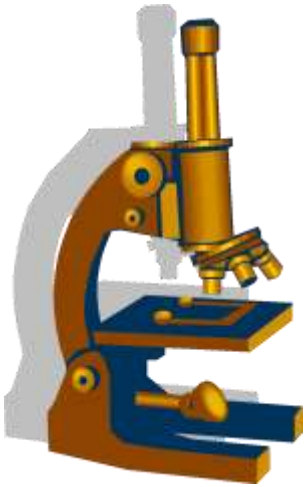

ARIKEN777




Stretch
Break!

How do scientists identify plankton?

- Scientists collect samples and carefully observe their characteristics
- They communicate these observations with sketches and photographs
- Today, you're the scientist!



Activity: Identifying Plankton

- You will see ten slides depicting marine specimens.

  Note: Species maybe estuarine, oceanic or riverine drift. Each slide will be visible for 2 minutes.

- As the slides are shown, observe and, using a pencil, sketch each sample on your worksheet. If there is more than one specimen on the slide, choose one to draw. **Note body shape, projections, sensory organs, appendages, type of covering and degree of transparency.**

Activity: Identifying plankton

- For each sample, write your hypothesis about the following two questions:
  - Is the organism phytoplankton or zooplankton?
  - Is it holoplankton or meroplankton?
- Following the drawing section, use your sketches and ANY resources or identify the specimens. You may work in teams by table.

Plankton Observation Worksheet

Specimen # _____

Characteristics: Description

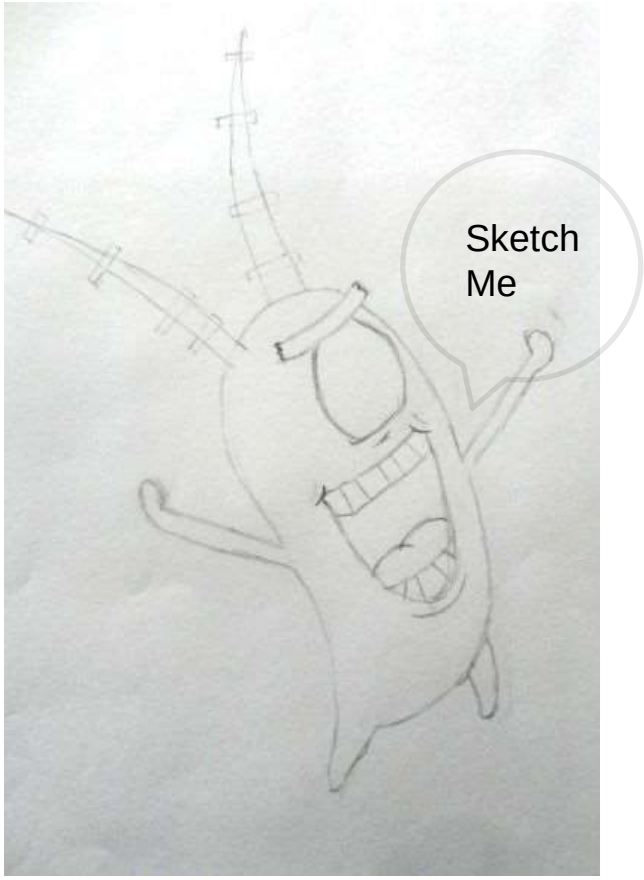
Body shape/Tail/flagella/appendages/eyes
Transparency/gills/color, other features

_____

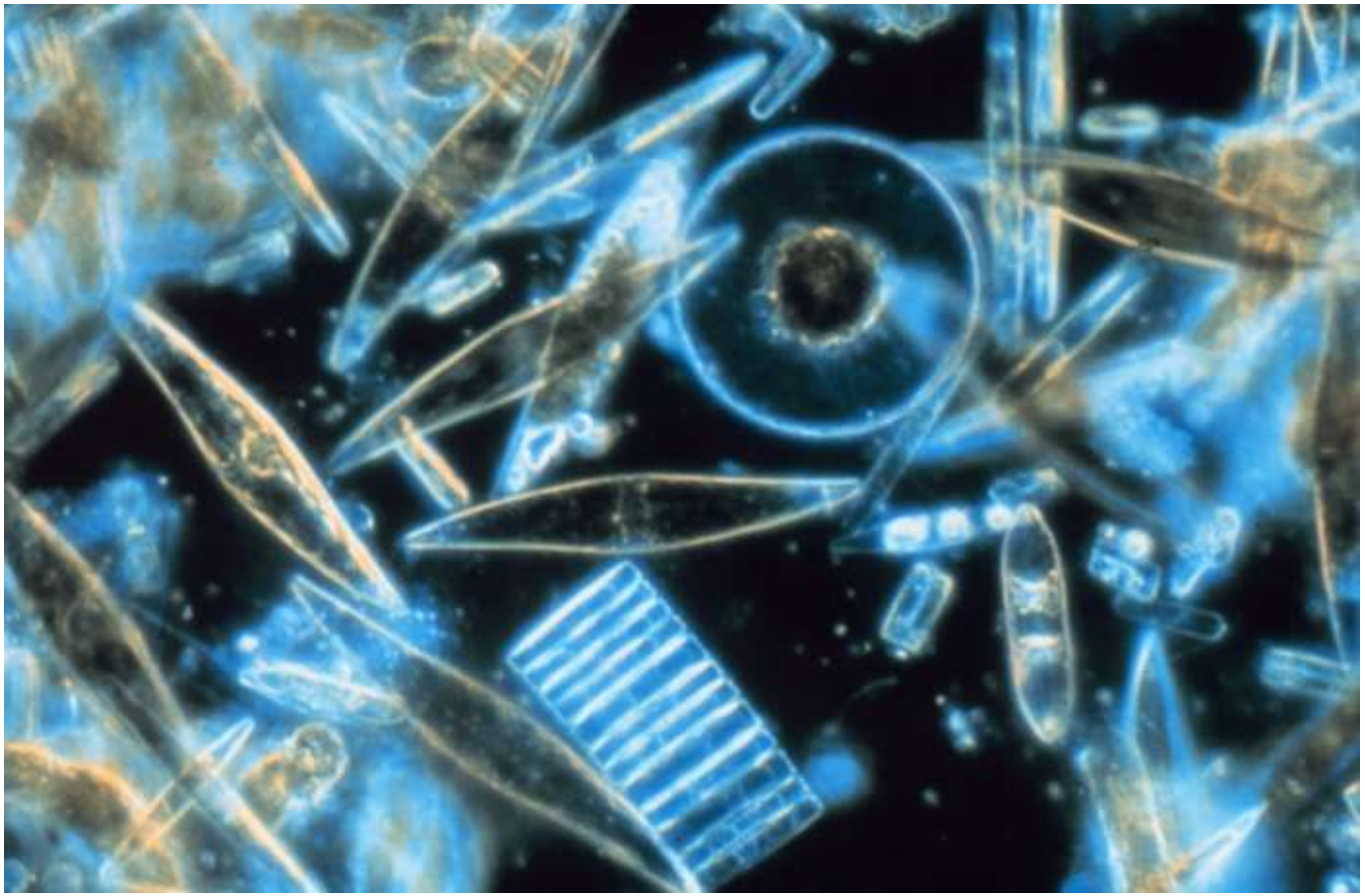
_____

_____

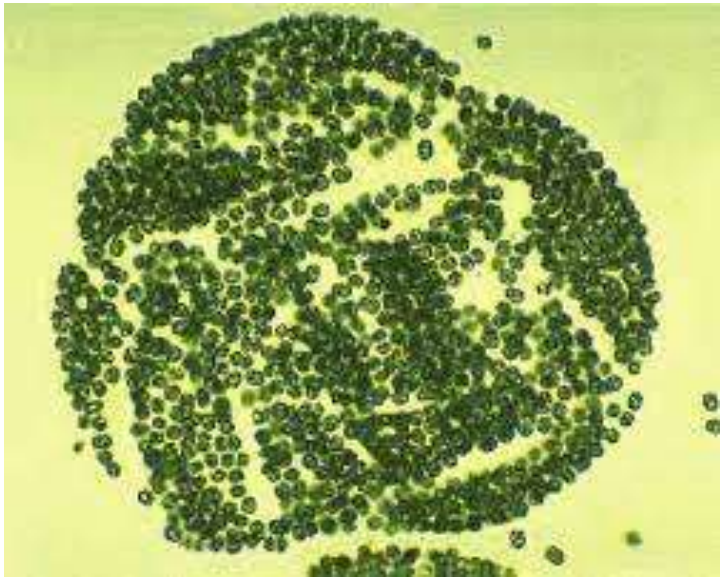
Indicate:
Phytoplankton or Zooplankton?
Holoplankton or Meroplankton?



Examples of Plankton Specimen #1

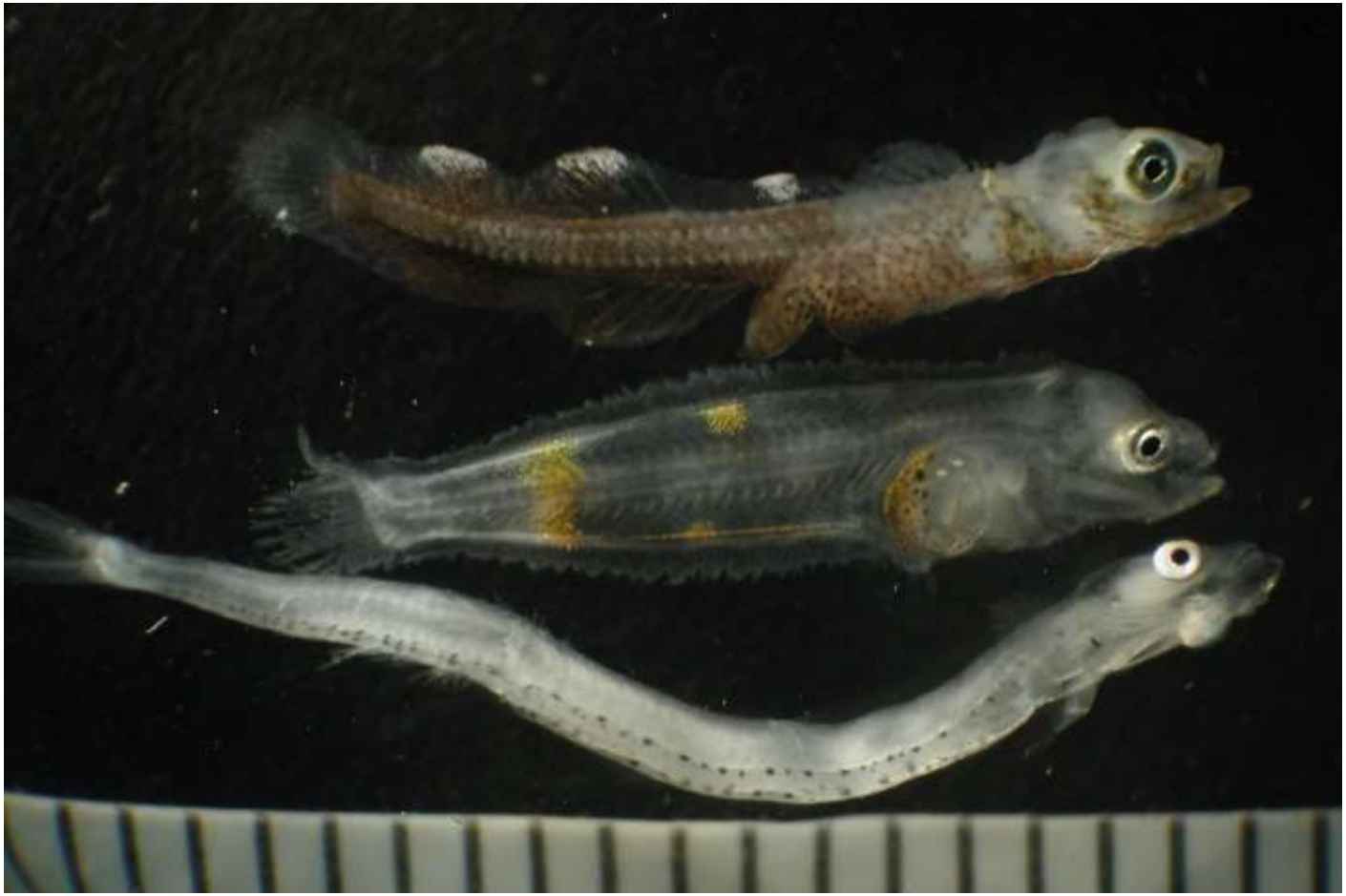


Specimen #2



Specimen #3

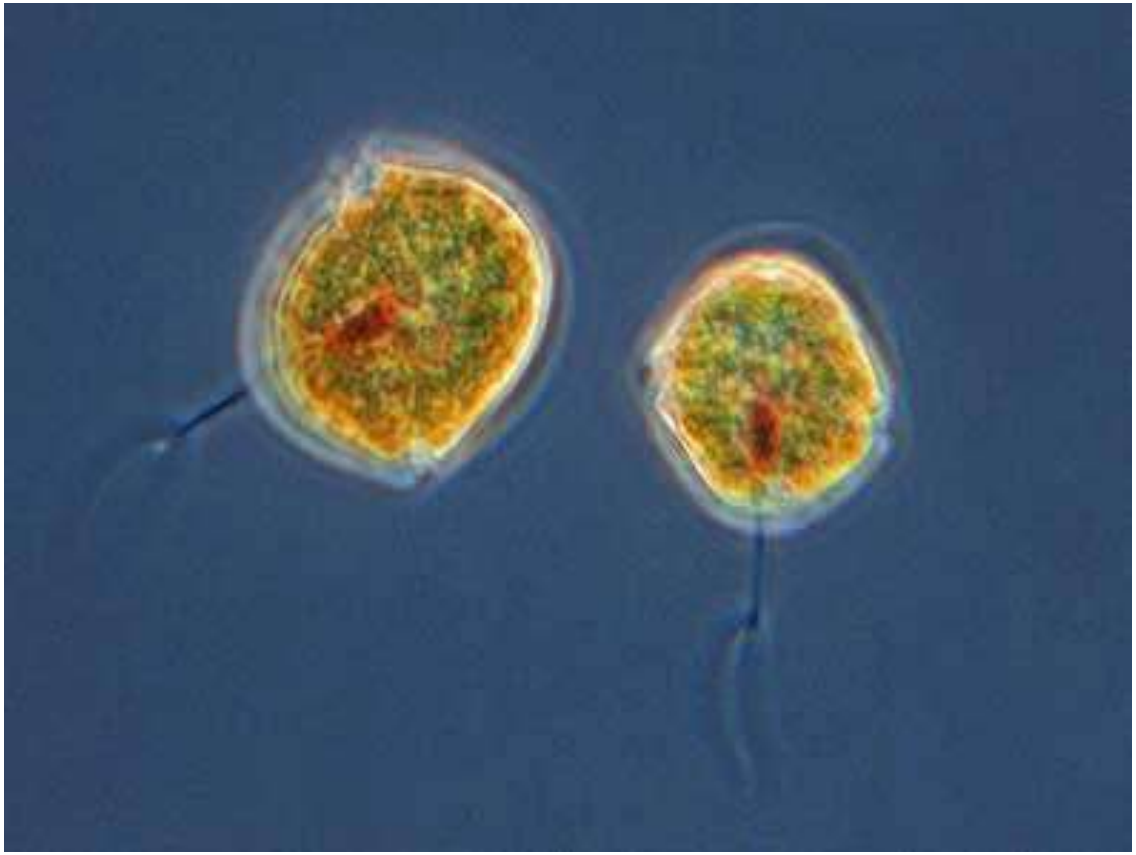
Specimen #4



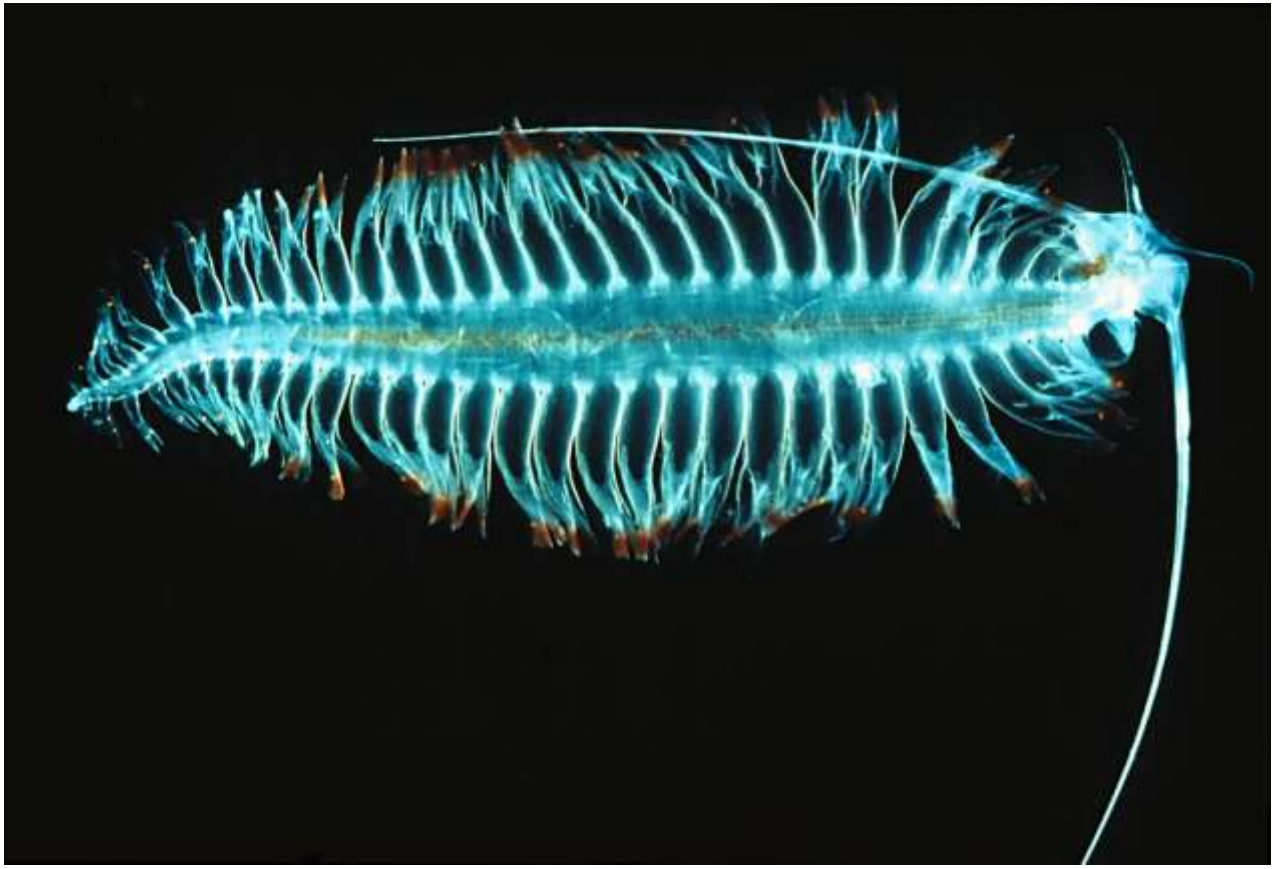
Specimen #5

Specimen #6

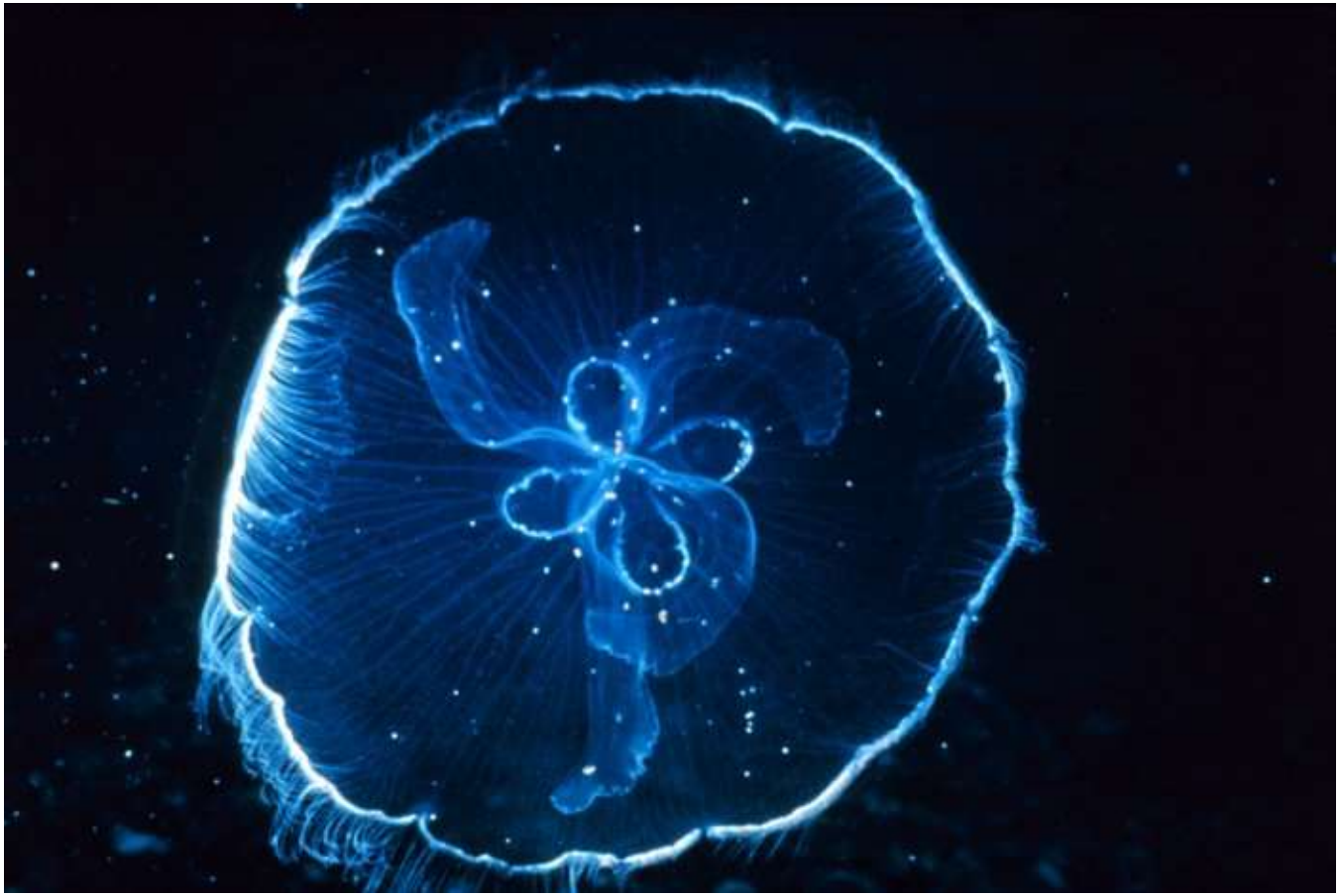
Specimen # 7



Specimen #8



Specimen #9



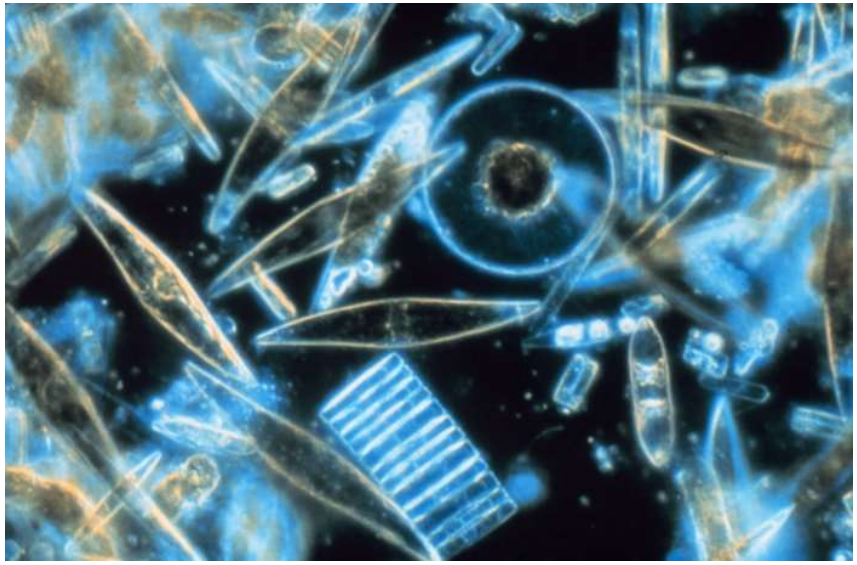
Specimen #10

End of Drawing Section

Now use your drawings to identify your specimens. Use any resources you have available or view the rest of the slides to discuss the specific organisms used.

Plankton Identified
Specimen #1 Mixed Diatoms

- Phytoplankton common in nutrient rich temperate, polar, coast and open ocean
- Important oxygen producer
- Occur as a single cell or in chains
- Covered in shells made of **silica**



Beautiful marine diatoms as seen through a microscope.
Image ID: corp2365, NOAA At The Ends of the Earth Collection
Photographer: Dr. Neil Sullivan, University of Southern Calif.

Specimen #2 Blue greens

- Bacteria, not algae
- HABs
- Cyanotoxins
- Liver toxin – can kill pets, live stock, fish
- Pathogen source
- Depletes oxygen, increase nutrients, smelly, irritation
- Can use ammonia & nitrogen

Specimen #3 – Copepod with Eggs

- Bristly appendages act as paddles and create water currents that draw individual phytoplankton cells close to feed on
- Many feed on zooplankton using claw like appendages to grab prey
- Eggs are attached to the tail

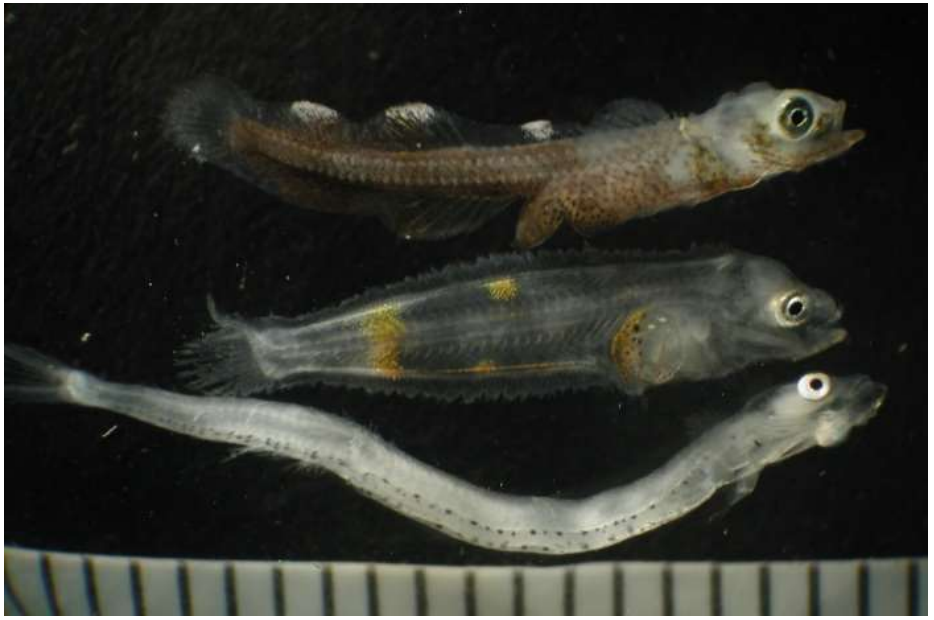
Zooplankton. Copepod with eggs.

Image ID: fish3261, NOAA's Fisheries Collection
Photographer: Matt Wilson/Jay Clark, NOAA NMFS AFSC

Specimen #4 – Fish Larvae

- Coastal waters are rich in meroplankton

  (temporary members of the plankton)
- Nearly all marine fish have planktonic larvae
- Fish larvae may change from herbivores to carnivores as they grow



Zooplankton. Fish larvae.

Image ID: fish3363, NOAA's Fisheries Collection
Photographer: Matt Wilson/Jay Clark, NOAA NMFS AFSC

Specimen #5 Snail

Larval snail. You can see the shell along the bottom, the delicate tissue which is the velum and the cilia which they use for feeding and moving.

NOAA

Specimen #6 Blue Crab Larva

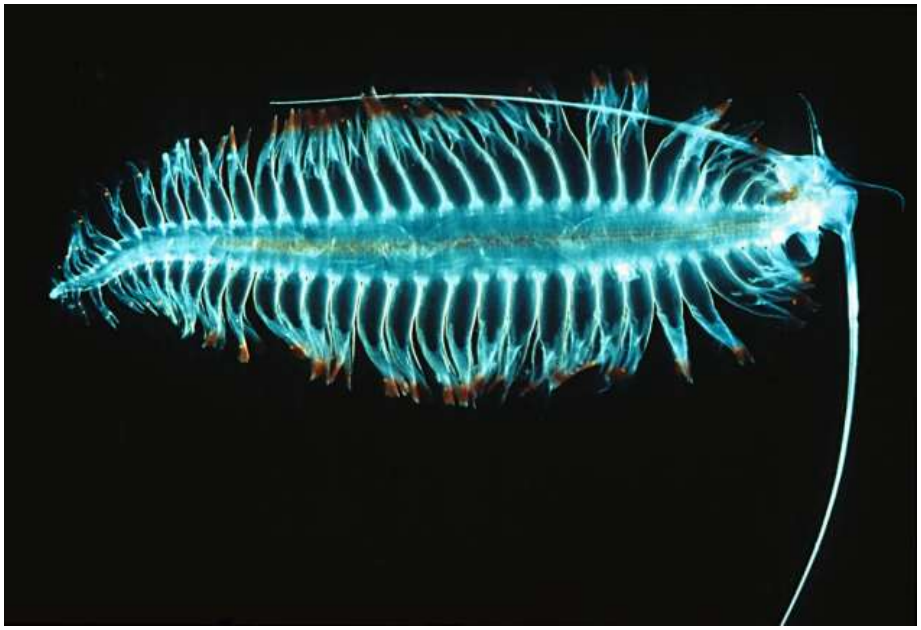
Well adapted to estuary
- Osmoregulate
- Defense/hide
- Tough exoskeleton
- Omnivores

Specimen # 7 Dinoflagellates

- Unicellular, phytoplankton
- Most have a cell wall (theca) with plates of cellulose with spines and pores
- May form blooms that color the water “Red Tides” or Harmful Algal Blooms (HABs)
- Produce bioluminescence (light)
- Some dinoflagellates live in symbiotic relationships with corals, giant clams, sea anemones.

Specimen #8 Polychaete

- Segmented Worms, bristly worms- Annelida
- Omnivores. Feed on detritus, zooplankton, algae
- Over 10,000 species
- Tube builders (benthic)
- Crawlers
- Planktonic



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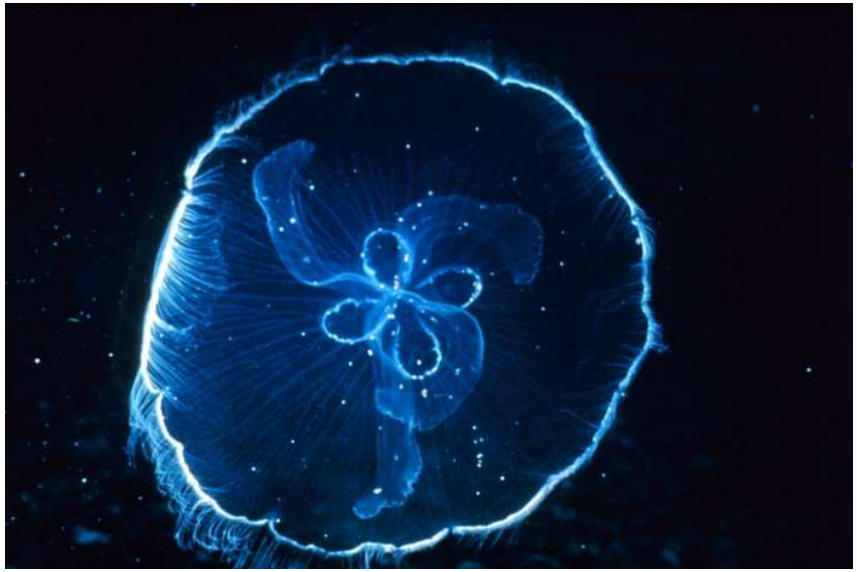
Specimen #9 Moon Jelly

- Gelatinous zooplankton
- Common in temperate and tropical waters
- Stinging cells are not toxic and don’t sting like other jellyfish
- 95% water but serve as food for many animals including turtles
- Feed by producing a sticky mucus that traps other plankton
- Reproduce sexually and asexually



- **Image ID:** reef2547, NOAA's Coral Kingdom Collection
  Photographer: Florida Keys National Marine Sanctuary Staff
  Credit: Florida Keys National Marine Sanctuary
  (moon jelly)

Specimen #10 Octopus Larva

- Temporary members of the plankton, octopus and squid become nektonic (free swimming) and benthic (crawling)
- Giant squid are the largest invertebrates in the ocean

Zooplankton. Octopus larva.

Image ID: fish3612, NOAA's Fisheries Collection
Photographer: Matt Wilson/Jay Clark, NOAA NMFS AFSC

Summary

Phytoplankton Foundation of the Food Web

- Primary Producers
  - Oxygen Production
  - Carbon Sequestration

Zooplankton

- Primary Consumers
- Food for 2nd Consumers (Fishes..Whales)

Plankton

- Crucial to Global Economy
- Supports World's Biodiversity
- Indicator of Ecosystem Health
- Enable's Biogeochemical Cycling

Thank you

- Questions
- Richard Whitman
- psammonman@gmail.com
- 219 406 0924

- Trivia question: What does psammon mean?

Background
MS Aquatic Toxicology
PhD Stream Ecology

University Years (10) Aquatic Sciences

***Parastenocaris texana,* New Species (Copepoda: Harpacticoida: Parastenocarididae) from an East Texas Sandy Stream with Notes on its Ecology.**
Journal of Crustacean Biology 4 (4), 695-700

Establishment of two invasive crustaceans (Copepoda: Harpacticoida) in the nearshore sands of Lake Michigan
Canadian Journal of Fisheries and Aquatic Sciences 58 (7), 1261-1264

Characterization of Lake Michigan coastal lakes using zooplankton assemblages
Ecological Indicators 4 (4), 277-286

Study of the application of limnetic zooplankton as a bioassessment tool for lakes of sleeping bear dunes national lakeshore
US Geological Survey

Ecological analysis of the Kentucky cave shrimp, *Palaemonias ganteri* Hay, at Mammoth Cave National Park
US Department of Interior.

Federal Years (25) Research Management, Recreational Water Quality
Beach Science. 150 +Journal Articles, 7100+ citations later